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(71) Applicant: HILL-ROM, INC. [US/US]; 1069 State Route 46 East, Batesville, IN 47006 (US).

(72) Inventors: DIXON, Steve, A.; 9553 Old Woods Drive, Hamilton, OH 45011 (US). MENKEDICK, Douglas, J.; 4617 North Dearborn Road, Guilford, IN 47022 (US). JACQUES, William, L.; 75 Arlington Drive, Batesville, IN 47006 (US). JONES, James, W.; 1155 N.W. 30th Avenue, Gainesville, FL 32609 (US). FINDLAY, James, F.; 7497 Timbemline Drive, Fishers, IN 46038 (US). WILKER, Jack, Jr.; 1418 Aaron Drive, Shelbyville, IN 46176 (US). OSBORNE, Eugene, E.; 2257 Kyle Drive, Hebron, KY 41048 (US).

(74) Agent: NIEDNAGEL, Timothy, E.; Bose McKinney & Evans LLP, 2700 First Indiana Plaza, 135 North Pennsylvania Street, Indianapolis, IN 46204 (US).

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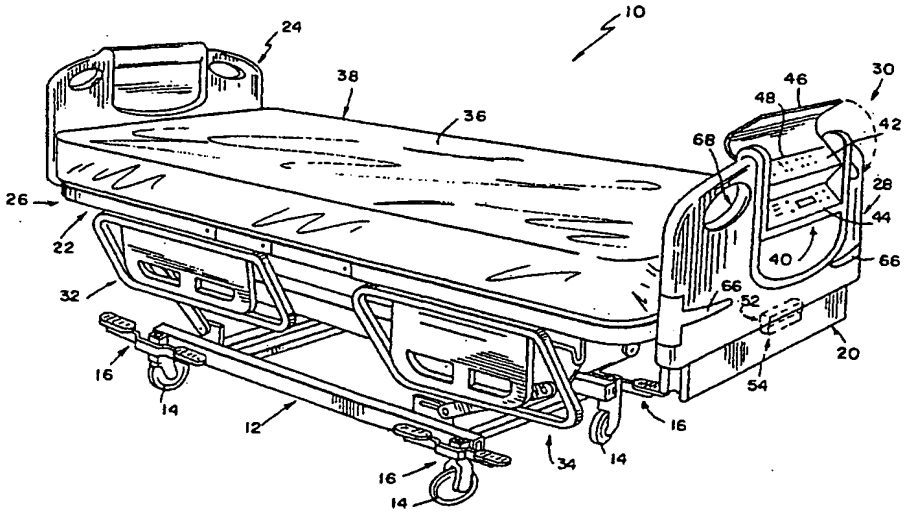

(57) Abstract

An apparatus is provided for detecting a position of a body on a support surface (38) of a bed (10). The apparatus includes at least one first sensor (70) coupled to the bed (10) and at least one second sensor (104) located adjacent the support surface (38). The at least one first sensor (70) has an output signal which is variable in response to changes in a weight applied to the support surface (38). The at least one second sensor (104) has an output signal which is variable in response to changes in the position of the body on the support surface (38). The apparatus also includes a controller (50) having inputs configured to receive the output signals from the first and second sensors (70, 104). The controller (50) is configured to monitor the output signals, to provide an indication of changes in the position of the body relative to the support surface (38), and to provide an indication if the body exits the support surface (38).

PATIENT POSITION DETECTION APPARATUS FOR A BED

Background Summary of the Invention

The present invention relates to a patient position detection apparatus for a bed. More particularly, the present invention relates to a bed exit and patient position detection apparatus which has multiple modes of operation for providing information to a caregiver regarding a location of a patient on a support deck of the bed and for providing an indication when the patient has exited the bed.

When a patient is required to stay in a hospital bed at a hospital or other patient care facility, it is desirable for a caregiver to be able to monitor the presence, absence, and location of the patient on the bed support surface and to monitor the patient's activity level. Caregivers within a hospital or other patient care facilities are continuously responsible for more and more activities. One of these activities is monitoring patients who need to be restricted to the bed or patients that are at a risk of falling or aggravating injuries if they exit the bed. Patients having certain patient profiles, such as confusion, weakness, or disorientation, are more likely to be injured or reinjured if they exit the bed. Patients with certain types of medical conditions therefore require monitoring of both their presence on the bed and their or location on the support surface. In this instance, the present invention provides an alarm when the patient moves out of the predetermined position on the bed, prior to exiting the bed.

Some patients are allowed by doctor's orders to move about freely on the bed in order to access the bed controls, a phone, or other items or to reposition themselves for comfort. In this situation, an alarm is only required if the patient totally exits the bed.

The present invention provides dual sensor mechanisms for detecting the location of the patient on the bed and for detecting bed exit. Therefore, the caregiver may select from various modes of operation depending upon the patient condition and profile. The apparatus of the present invention detects the presence or absence of the patient on the bed and also detects the position of the patient on the support surface. Therefore, the present invention allows proper patient monitoring to be applied at the discretion of the caregiver for the correct patient situation.

In the exiting mode and position mode, an alarm will also be activated if the patient exits the bed. In other words, in exiting mode and position mode, the out-of-bed detector is also used.

The alarm tones of the apparatus may be selected from a number of various tone options. Different sounds or visual indicators may be provided for each of the modes, if desired. In one illustrated embodiment, the patient positioning system is configured to deactivate the alarm if the patient gets back into bed or returns to the correct position on the bed. The apparatus also includes a button, switch, etc. located on the bed which will send a signal to reset or clear the "nurse call" alarm which is activated at a remote nurse station when a patient alarm is generated by the apparatus. This button allows the nurse to clear the remote bed exit/patient position alarm while at the bed after responding to the alarm. Currently, nurses have to clear the bed exit/patient position alarm by returning to the nurse call station or by deactivating the alarm somewhere else in the hospital, other than at the bed. Another illustrated embodiment of the invention is configured to turn on the room lights when an alarm is activated.

According to an illustrated embodiment of the present invention, an apparatus is provided for detecting a position of a body on a support surface of a bed. The apparatus includes at least one first sensor coupled to the bed and at least one second sensor located adjacent the support surface. The at least one first sensor has an output signal which is variable in response to changes in a weight applied to the support surface. The at least one second sensor has an output signal which is variable in response to changes in the position of the body on the support surface. The apparatus also includes a controller having inputs configured to receive the output signals from the first and second sensors. The controller is configured to monitor the output signals, to provide an indication of changes in the position of the body relative to the support surface, and to provide an indication if the body exits the support surface.

In the illustrated embodiment, the first and second sensors are different types of sensors. The at least one first sensor is illustratively a load cell or other suitable sensor. The at least one second sensor is illustratively a resistive pressure sensor, a capacitance sensor, a piezoelectric sensor, or other suitable sensor.

The illustrated apparatus further includes first, second, and third mode indicator lights located on the bed which correspond to the first, second, and third modes of operation of the controller, respectively. The controller is coupled to the first, second, and third mode indicator lights. The controller is configured to illuminate the first mode indicator light when the controller is in the first operation mode, to illuminate the first and second mode indicator lights when the controller is in the second operation mode, and to illuminate the first, second, and third mode indicator lights when the controller is in the third operation mode.

The illustrated apparatus includes a control panel coupled to the controller to permit a caregiver to select between the first and second modes of operation. The control panel is illustratively either coupled to a siderail of the bed, located on a pendant coupled to the controller, coupled to the controller by a remote control transmitter, or located elsewhere on the bed.

In an alternative embodiment of the present invention, the controller is configured to activate the alarm when the patient is out of a predetermined position on the support surface. The controller is also configured to detect when the body moves back into the predetermined position on the support surface and automatically deactivate the alarm upon detection of the body moving back into the predetermined position on the support surface.

In yet another embodiment, the controller is configured to monitor movement of the body on the support surface. The controller is configured to generate an output signal if a predetermined amount of movement of the body is not detected within a predetermined period of time.

In an illustrated embodiment, the controller includes an output coupled to a communication port to provide a nurse call alarm upon detection of the body moving out of a predetermined position on the support surface of the bed. A nurse call clear actuator is coupled to the bed. The nurse call clear actuator is configured to clear the nurse call alarm. The controller also is configured to transmit an output signal through the communication port to a remote location over a communication network.

According to another illustrated embodiment of the present invention. An apparatus is provided for detecting a position of a body on a support surface of a

the first, second, and third mode indicator lights when the controller is in the third operation mode.

According to yet another illustrative embodiment of the present invention, a bed includes a base, a support surface coupled to the base, a controller configured to control an entertainment device including at least one of a television, a radio, a stereo, a video player, and a computer, and an entertainment control panel coupled to the controller. The entertainment control panel includes inputs to permit an operator to control operation of the entertainment device. The apparatus also includes a lockout switch coupled to the controller. The lockout switch is configured to disable the entertainment control panel when the lockout switch is actuated.

In the illustrated embodiment, an indicator light is coupled to the controller. The indicator light is illuminated when the lockout switch is actuated. The indicator light is illustratively coupled to a siderail of the bed spaced apart from the lockout switch. The lockout switch is illustratively coupled to a footboard of the bed. A cover is coupled to the footboard. The lockout switch being concealed beneath the cover.

According to still another embodiment of the present invention, a bed includes a base, a support surface coupled to the base, a controller configured to control a plurality of functions including at least one of a night light, a back light, a head articulation actuator, a knee articulation actuator, a hi/lo actuator, and an entertainment device, and a control panel coupled to the controller. The control panel includes a plurality of inputs to permit an operator to control the plurality of functions. The apparatus also includes a plurality of lockout switches coupled to the controller and an indicator located on the bed spaced apart from the plurality of lockout switches. The controller is configured to disable operation of selected functions by the control panel upon actuation of corresponding lockout switches. The indicator is configured to provide an indication when at least one of the lockout switches is actuated to disable operation of at least one of the functions.

Illustratively, the indicator is coupled to a siderail of the bed and the plurality of lockout switches are located on a footboard of the bed. Each of the plurality of lockout switches illustratively includes a separate light located adjacent the lockout switch to indicate when the lockout switch is actuated.

configured to be inserted into the at least one aperture of the frame. The at least one aperture of the frame is larger than the at least one retention post to permit the limited movement of the second connector alignment apparatus relative to the frame of the bed.

Additional features and advantages of the invention will become apparent to those skilled in the art upon consideration of the following detailed description of illustrated embodiments exemplifying the best mode of carrying out the invention as presently perceived.

Brief Description of the Drawings

The detailed description particularly refers to the accompanying figures in which:

Fig. 1 is a perspective view of a hospital bed which includes a patient position detection apparatus in accordance with the present invention and which includes a footboard having an electrical connector alignment apparatus of the present invention;

Fig. 2 is an end view of the footboard of Fig. 1 illustrating further details of the electrical connector alignment apparatus;

Fig. 3 is an exploded perspective view of portions of the hospital bed of Fig. 1 illustrating a base frame, a weigh frame, an intermediate frame, a retracting frame, an articulating deck, a first set of sensors for detecting the weight of a patient on the deck, and a second set of sensors located on the articulating deck for detecting the position of the patient on the deck;

Fig. 4 is a partial sectional view illustrating a load cell configured to connect the weigh frame to the base frame;

Fig. 5 is a perspective view of a head end siderail which includes a control panel for operating the patient position detection apparatus of the present invention;

Fig. 6 is an enlarged view of the control panel of Fig. 5 which is used to control the mode of operation of the patient position detection apparatus and the volume of the alarms generated by the detection apparatus;

coupled to the intermediate frame 19 and the retracting frame 20. Brackets 21 on opposite sides of frame 20 are configured to be coupled between the head section 106 and the thigh section 110 of deck 22 with suitable fasteners (not shown).

Referring again to Fig. 1, the bed 10 includes a headboard 24 mounted adjacent a head end 26 of the bed 10 and a footboard 28 mounted to the frame 20 adjacent a foot end 30 of bed 10. Bed 10 further includes a pair of head end siderails 32 and a pair of foot end siderails 34 mounted to the articulating deck 22 on opposite sides of the bed 10. Further details of head end siderail 32 are illustrated in Fig. 5. Siderails 32 and 34 are coupled to the articulating deck 22 in a conventional manner using a connector mechanism 35 best shown in Fig. 5. The siderails 32 and 34 are movable from a lowered position shown in Fig. 1 to an elevated position (not shown) located above a top surface 36 of mattress 38. Mattress 38 is located on articulating deck 22 for supporting a patient thereon.

The footboard 28 includes a plurality of buttons, knobs, switches or other controls 40 for controlling various functions of the bed 10. Controls 40 are located on a top inclined panel 42 and a bottom inclined panel 44 on the footboard 28. A cover 46 is pivotably coupled to the footboard 28 by a pivot connection 48 so that the cover can be pivoted downwardly to conceal at least the controls 40 located on the top inclined panel 42.

One of the controls on the footboard 28 is illustratively a lockout button 61 for entertainment functions which are controlled by patient input control panels on the bed 10. In other words, a caregiver can press button 61 to lock out entertainment functions on the bed 10. An indicator light is provided adjacent the entertainment lockout control 61 to provide an indication when the entertainment lockout 61 is activated. When the entertainment lockout 61 is activated, the patient cannot turn on the television, radio, stereo, video player, computer or other entertainment device typically available on the bed or in the room. The entertainment lockout control 61 is illustratively located below the cover 46 on the footboard 28. It is understood, however, that the entertainment lockout may be located at other positions on the bed.

The bed 10 also includes a plurality of lockout switches 63 which are illustratively located on the footboard 28. It is understood that the lockout switches

The patient position detection apparatus of the present invention uses two different types of sensors 70, 104. A first set of sensors 70 is used to detect when a patient exits the bed 10. A second set of sensors 104 is used to determine a position of the patient on the deck 22 of the bed 10. In the illustrated embodiment, the first type of sensors include load cells 70 which are mounted at the four corners of the weigh frame 18. Details of the mounting of the load cells 70 between the base frame 12 and the weigh frame 18 are illustrated in Figs. 3 and 4. Base frame 12 includes side frame members 72 and transverse frame members 74 extending between the side frame members 72. Weigh frame 18 includes a pair of hollow side frame members 76. Load cells 70 are well known. Load cells 70 typically include a plurality of strain gauges located within a metal block.

As best shown in Fig. 4, a mounting ball 78 is coupled to the load cell 70. Illustratively, mounting ball 78 includes a threaded stem which is screwed into threads in the load cell 70. Mounting ball 78 is located within an aperture 80 formed in a mounting block 82. Mounting blocks 82 are secured to the transverse frame members 74 by suitable fasteners 84 at the four corners of the base frame 12. A mounting bar 86 is coupled to an arm 88 of load cell 70 by fasteners 90. Mounting bar 86 is then secured to a top surface 92 of side frame member 76 of weigh frame 18 by suitable fasteners 94 and washers 96. Mounting bar 86 is not coupled to arm 98 of load cell 70. Therefore, load cell 70 may be deflected downwardly in the direction of arrow 100 when weight is applied to the weigh frame 18. Such deflection in the direction of arrow 100 changes an output voltage which provides an indication of weight change on the weigh frame. Load cells 70 are coupled to a signal conditioner 53 by wires 102. The signal conditioner 53 is then coupled to the controller 50 on the bed 10 by wires 102.

Although the specification and claims of this application refer to a controller 50, it is understood that the bed 10 will typically include several controllers which control different functions on the bed. These controllers may be located at any location on the bed and are not limited to the location illustrated in Fig. 3. The controllers 10 typically are microprocessor based controllers. Output signals from various devices may need to be conditioned prior to being coupled to the controller. For instance, analog signals may need to be converted to digital signals for processing

25 of deck 22 or on the deck 22 near the head end 26 or foot end 30. In other words, a pre-exit alarm is sounded when the patient moves outside a central portion of the deck 22 on the bed 10. In a third position mode, both sets of sensors 70, 104 are also used. An alarm is activated when a patient moves away from the head sensor 114 on the deck 22 as discussed below.

Fig. 7 is a block diagram illustrating the electronic control components of the patient position detection apparatus. As discussed above, the first and second sensors 70 and 104 are each coupled to the controller 50. The controller 50 processes signals from the first and second sensors 70, 104 as discussed in detail below to provide various control functions. A caregiver control panel 130 is mounted on the bed 10 to control operation of the patient position detection apparatus. Preferably, the caregiver control panel 130 is mounted on the head end siderail 52 as best shown in Fig. 5. The control panel 130 may also be on a pendant or on a remote control device electrically coupled to the controller 50. The caregiver control panel 130 includes control buttons, switches, knobs, etc. for setting the particular type of tone for the audible alarm and for setting a volume of the alarm for each of the detection modes as illustrated at block 132. In addition, the caregiver control panel 130 includes control buttons, switches, knobs, etc. to set the particular type of detection mode for the apparatus as discussed below. Inputs from the caregiver control panel 130 are transmitted to the controller 50. Controller 50 also transmits signals to the caregiver control panel 130 to control indicator lights 136 on the caregiver control panel 130.

If an alarm condition is detected by controller 50 as discussed below in detail, controller 50 controls either audible or visual local alarms 138 within the room or on the bed 10. Controller 50 may also be used to turn on the room lights 140 when an alarm condition is detected. Finally, the controller 50 activates a nurse call alarm 142 to send an indication of the alarm condition to a nurse station located at a remote location.

The apparatus of the present invention further includes a nurse call reset or clear button 144 located on the bed 10. This clear button 144 sends a signal to controller 50 to clear the nurse call 142 alarm once the nurse call 142 alarm has been activated at the remote nurse call station. Nurse call clear button 144 permits the caregiver to clear or reset the remote patient alarm while at the bed 10 after

volumes. The caregiver can change the volume of the alarm between a high setting, a medium setting, and a low setting by pressing the key button 150 and simultaneously pressing the volume button 154. Subsequent presses of the volume button 154 change the volume to different levels. Indicator LEDs 162, 164, and 166 are provided for the high, medium, and low volumes, respectively. If the high volume level is selected, all three LEDs 162, 164, and 168 are lit. If the medium volume level is selected, LEDs 164 and 168 are lit. If the low volume level is selected, only LED 168 is lit. By providing a different number of indicator lights for each volume level, a caregiver can tell the volume level for the alarm in the dark. When the patient position detection apparatus is off, all the volume LEDs 162, 164, and 168 are off.

When a local alarm condition is detected by controller 50 as discussed below. An appropriate LED for Position Mode, Exiting Mode, and Out-of-Bed Mode will flash on the control panel 30 to indicate an alarm condition for that mode. More than one of the LEDs 156, 158, and 160 can flash. For instance, in Position Mode, the Position Mode LED 156 may begin to flash when an alarm condition is detected by the Position Mode. Since the Out-of-Bed Mode is also run in Position Mode, the Out-of-Bed LED 160 may also be flashing if the patient has exited the bed.

Caregiver control panel 130 also includes an indicator LED 170 to provide an indication that the bed 10 is not down. This indicator LED 170 is lit when the deck 22 is not in its lowest position relative to the floor. In addition, caregiver panel 130 includes an indicator LED 172 which provides an indication when the brake on the casters 14 is not set. When positioned in a room, the bed 10 is typically set so that the deck 22 is in its lowest position and the brake is set. Therefore, indicator LEDs 170 and 172 provide the caregiver with an indication that these conditions are not met.

Fig. 8 shows the illustrative arrangement of the sensors 114, 120, 122, and 124 on the articulating deck 22. It is understood that other arrangements of the second set of sensors 104 may be used in accordance with the present invention. In addition, additional sensors may be provided such as a sensor 125 located on the leg deck section 112. Although the second sensors 104 are illustratively resistive sensors, it is understood that other types of sensors may be used in accordance with the present invention. For example, capacitance sensors such as shown in U.S. Patent

block 222. Controller 50 then determines whether the sensor values are within the preset specifications as illustrated at block 224. In the position mode, controller 50 is only concerned with the head sensor 114. Therefore, in position mode, the output from head sensor 114 is checked. The output value from sensor 114 is within specification if the head sensor 114 output signal corresponds to a range of weights between 50-450 lbs. Therefore, for position mode, the sensor 114 is typically not within specification if the head sensor 114 is not plugged in, shorted, or if a patient is not on the bed 10.

For exiting mode, controller 50 checks all the load cells 70 and sensors 114, 120, 122, and 124. To be within specification for exiting mode, the weight range detected by load cells 70 must be within a predetermined range based on average human weights. Controller 50 also determines whether any of the sensors 114, 120, 122, or 124 are not plugged in or are shorted. In the out-of-bed mode, controller 50 only looks at load cells 70 to make sure that at least a predetermined minimum weight reading is obtained in order to indicate that a patient is on the bed 10.

If the values read at block 222 are not within specifications, controller 50 will send a local alarm as illustrated at block 226 so that the caregiver can investigate the problem as illustrated at block 226. Controller 50 then turns the detection system off as illustrated at block 227 and advances to block 230 as illustrated at block 229. If the retrieved sensor values are within the specifications at block 224, controller 50 stores all the sensor values in memory 51 as illustrated at block 228. Controller 50 then advances to block 230 as illustrated at block 229.

In the illustrated embodiment, the key button 150 on control panel 130 is a hardware switch. If the key button 50 is not pressed, the controller 50 does not receive the signal from the mode button 152 or the volume button 154. Therefore, if the key button is not pressed as illustrated at block 232, controller 50 returns to block 200 as illustrated at block 244. If the key button 150 and the mode button 152 are pressed as illustrated at block 234, the controller 50 will receive an input based on the mode button press. If the key button 150 and the volume button 154 are pressed as illustrated at block 236, the controller 50 will receive an input signal from the volume button 154 press. If the key button 150, the mode button 152, and the volume button 154 are all pressed as illustrated at block 238, the controller 50 will receive input

Operation of the patient detection system in exiting mode is illustrated beginning at block 264 in Fig. 12. Controller 50 advances to block 264 from block 218 in Fig. 9. In exiting mode, controller 50 first runs the positioning mode loop as illustrated at block 266. In other words, the controller 50 uses head sensor 114 to check the patient's position using the flow chart discussed above in reference to Fig. 11. Controller 50 determines whether the current head sensor value CV is within the acceptable range as illustrated at block 268. If so, controller 50 determines that the patient is in the proper position and advances to block 278 to run the out-of-bed mode check as illustrated at block 276 in Fig. 12.

If the head sensor value is not within the acceptable range at block 268, controller 50 runs a sensor test for seat sensor 120 and thigh sensors 122 and 124 using a similar test as in Fig. 11. Scaler values may be adjusted for the different sensors 120, 122, and 124, if necessary. Scaler values are selected by applying a known load above a particular sensor location and taking an output reading. Next, a predetermined distance from the sensor is selected at which point it is desired to activate the alarm. The known weight is than moved to that desired alarm location and another output reading is taken. The scaler value is calculated the percentage change between the output of the sensor when the known weight applied directly over the sensor and the output of the sensor when the known weight applied at the predetermined distance perpendicular to the sensor.

Controller 50 then determines whether two of the three remaining sensors 120, 122, and 124 are within acceptable ranges as illustrated at block 272 by comparing the current sensor values to ranges based on the corresponding stored sensory values. If so, controller 50 determines that the patient is in an acceptable position on the deck 22 and advances at block 230 as illustrated at block 276. If two of the three sensors are not within the acceptable ranges at block 272, controller 50 determines that the patient is out of position and updates the local alarms 238, activates the nurse call alarm 142, and may turn on the room lights 140 as illustrated at block 274. Controller 50 then advances to block 230 as illustrated at block 276. In exiting mode, the patient position detection apparatus of the present invention permits the patient to move around more on the deck 22 before an alarm is activated compared

than 30 lbs. at block 296, controller 50 clears the local alarm only at block 300 and then advances to block 230 as illustrated at block 294.

It is understood that the 30 lbs. threshold value for the out-of-bed mode may be adjusted upwardly or downwardly depending upon the weight of the patient. In other words, if the patient is particularly heavy, the 30 lb. threshold may be increased, for example.

It is understood that the patient detection apparatus of the present invention may have more than three modes of operation if desired. The separate modes may have different sensitivity levels.

The out-of-bed mode of the present invention may be armed with the patient in the bed 10. In some beds having scales, the patient must be removed in order to determine a tare weight of the bed prior to the patient getting into the bed in order to arm the bed exit detector. In the out-of-bed mode of the present invention, removing the patient from the bed is not required in order to arm the bed exit detection system.

The patient position detection system of the present invention may be quickly switched from a normal bed exit system in which an alarm is generated only when a patient exits the bed to a predictive bed exit system in which an alarm is generated when a patient moves away from a center portion of the bed. In an embodiment of the invention, the output signals from the first and second set of sensors 70, 104 are monitored and stored, either at the bed 10, or at a remote location to record movements of the patient. The controller 50 or a controller at the remote location monitors the sensor output values to determine whether the patient is moving on the bed 10. In one embodiment, the controller 50 or controller at a remote location generates a caregiver alert signal or alarm if the patient has not moved on the bed within a predetermined period of time. Therefore, the caregiver can go to the bed 10 and rotate the patient in order to reduce the likelihood that the patient will get bed sores. For example, if the patient hasn't moved for a predetermined period of time, such as two hours, a signal is generated advising the caregiver to move the patient. If the sensors 70, 104 and controller detect that the patient has moved within the predetermined period, then there is no need for the caregiver to go turn the patient.

62 perform the same or similar function. Connectors 64 include female socket contacts 318 configured to receive terminals 312 of connector 302. Illustratively, cables extending from connectors 64 are coupled to the controller 50 on bed 10.

Referring now to Fig. 14, connector alignment apparatus 52 includes a base plate 320 having outwardly extending alignment posts 322 located at opposite ends. Posts 322 each include tapered head portions 324. Alignment apparatus 52 includes a pair of connector receiving portions 326. Connector receiving portions 326 each include a pair of center posts 328. Each post 328 includes a pair of spring arms 330. Each spring arm 330 has a head portion 332 including a ramp surface 334 and a bottom lip 336. Each connector receiving portion 326 also includes a pair of posts 338.

Electrical connectors 62 are installed into the connector receiving portions 326 by locating the apertures 310 on flanges 308 over the posts 338 and pushing the connector 62 toward base 320. Flanges 306 engage ramp surfaces 334 of heads 332 and cause the spring arms 330 to be deflected. Once the flanges 306 move past the heads 332, heads 332 then move over flanges 306 to retain the connectors 302 within the connector alignment apparatus 52 as best shown in Fig. 16.

Second connector alignment apparatus 54 is best illustrated in Fig. 15. The alignment apparatus includes a body portion 340 having a pair of downwardly extending alignment posts 342. Body portion 340 is formed to include apertures 344 at opposite ends. Apertures 344 are configured to receive the posts 322 of first connector alignment apparatus 52 as discussed below. Lead-in ramp surfaces 346 are formed around the apertures 344. Body portion 340 further includes a pair of connector receiving portions 348 which function the same as connector receiving portions 326 described above. Reference numbers the same as in Fig. 14 perform the same or similar function. Apertures 310 formed in flanges 308 of connectors 64 are inserted over the posts 338 of the connector receiving portions 348. The connectors 64 are then pushed downwardly to deflect the heads 332 until the lips 336 move over flanges 306 to lock the connectors 64 within the housing 340 as discussed above.

The first connector alignment apparatus 52 and the second connector alignment apparatus 54 each may include a key shown diagrammatically at locations 349 and 351, respectively. Certain beds have different features which are controlled

second connector alignment apparatus 54, and posts 313 on connectors 62 which mate with apertures 315 on the connectors 64 to provide further alignment.

Although the invention has been described in detail with reference to certain illustrated embodiments, variations and modifications exist within the scope and spirit of the invention as described and as defined in the following claims.

9. The apparatus of claim 1, wherein the support surface of the bed includes a deck and a mattress located on the deck, the at least one second sensor being coupled to the mattress.

10. The apparatus of claim 9, wherein the at least one second sensor is located within an interior region of the mattress.

11. The apparatus of claim 1, wherein the support surface of the bed includes a deck and a mattress located on the deck, the at least one second sensor being coupled to the deck.

12. The apparatus of claim 11, wherein the deck includes a head deck section, a seat deck section, a thigh deck section, and a leg deck section, and the second sensors include at least one head sensor coupled to the head deck section, at least one seat sensor coupled to the seat deck section, and at least one thigh sensor coupled to the thigh deck section.

13. The apparatus of claim 12, wherein two spaced apart thigh sensors are coupled to the thigh deck section.

14. The apparatus of claim 12, wherein the head sensor is an elongated strip which extends in a direction parallel to a longitudinal axis of the deck, the head sensor being located at a center portion of the head deck section.

15. The apparatus of claim 14, wherein two elongated thigh sensors are coupled to the thigh deck section, the elongated thigh sensors extending in a direction parallel to the longitudinal axis of the deck.

16. The apparatus of claim 15, wherein the seat sensor is an elongated strip which is configured to extend in a direction transverse to the longitudinal axis of the deck.

17. The apparatus of claim 12, wherein the second sensors further include at least one leg sensor coupled to the leg deck section.

18. The apparatus of claim 12, further comprising an alarm coupled to the controller, the controller having a first mode of operation in which the alarm is activated by the controller only when the at least one first sensor detects that the body has exited the bed, a second mode of operation in which the alarm is activated by the controller when the head, seat and thigh sensors detect that the body has moved away from a central portion of the support surface, and a third mode of operation in which

28. The apparatus of claim 23, wherein the control panel includes a key button and a separate mode button, the controller permitting the caregiver to change the mode of operation by pressing the mode button only when the key button is also pressed.

29. The apparatus of claim 28, wherein the control panel also includes a volume control button, the controller being configured to permit the caregiver to adjust the volume of the alarm using the volume control button only when the key button is also pressed.

30. The apparatus of claim 23, further comprising at least two indicator lights coupled to the control panel to provide a visual indication of the mode of operation of the controller.

31. The apparatus of claim 1, further comprising an alarm coupled to the controller, the controller being configured to activate the alarm when the patient is out of a predetermined position on the support surface, the controller being configured to detect when the body moves back into the predetermined position on the support surface, and the controller automatically deactivating the alarm upon detection of the body moving back into the predetermined position on the support surface.

32. The apparatus of claim 1, wherein the controller is configured to monitor movement of the body on the support surface, the controller being configured to generate an output signal if a predetermined amount of movement of the body is not detected within a predetermined period of time.

33. The apparatus of claim 1, wherein the controller includes an output coupled to a communication port to provide a nurse call alarm upon detection of the body moving out of a predetermined position on the support surface of the bed.

34. The apparatus of claim 33, further comprising a nurse call clear actuator coupled to the bed, the nurse call clear actuator being configured to clear the nurse call alarm.

35. The apparatus of claim 1, wherein the controller includes an output coupled to a communication network, the controller being configured to transmit a data to a nurse station over the communication network, the data including information related to at least one of a patient weight, a patient position on the support

42. The apparatus of claim 38, wherein the control panel also includes an alarm volume control button, the controller being configured to permit the caregiver to adjust the volume of the alarm using the volume control button only when the key button is also pressed.

43. The apparatus of claim 38, wherein the control panel includes an actuator to permit a tone of the alarm to be selected from a plurality of different tones.

44. The apparatus of claim 38, wherein the controller is configured to turn on a room light wherein the alarm signal is generated.

45. The apparatus of claim 38, wherein the controller has first, second and third different modes of operation, the alarm being activated by the controller when different levels of patient movement on the support surface are detected for the first, second and third modes of operation.

46. The apparatus of claim 45, further comprising first, second, and third mode indicator lights located on the control panel which correspond to the first, second, and third modes of operation of the controller, respectively, the controller being coupled to the first, second, and third mode indicator lights.

47. The apparatus of claim 46, wherein the controller is configured to illuminate the first mode indicator light when the controller is in the first operation mode, to illuminate the first and second mode indicator lights when the controller is in the second operation mode, and to illuminate the first, second, and third mode indicator lights when the controller is in the third operation mode.

48. A bed comprising:

a base;

a support surface coupled to the base;

a controller configured to control an entertainment device including at least one of a television, a radio, a stereo, a video player, and a computer;

an entertainment control panel coupled to the controller, the entertainment control panel including inputs to permit an operator to control operation of the entertainment device; and

56. The apparatus of claim 53, wherein each of the plurality of lockout switches includes a light located adjacent the lockout switch to indicate when the lockout switch is actuated.

57. An apparatus for aligning a first electrical connector electrically coupled to a control panel located on a removable member of a bed with a second electrical connector electrically coupled to a controller on the bed, the apparatus comprising:

a first connector alignment apparatus having a connector receiving portion configured to secure the first electrical connector to the first connector alignment apparatus;

a second connector alignment apparatus having a connector receiving portion configured to secure the second electrical connector to the second connector alignment apparatus;

a first fastener configured to couple the first connector alignment apparatus to the removable member of the bed; and

a second fastener configured to couple the second connector alignment apparatus to a frame of the bed, one of the first and second connector alignment apparatuses including at least one alignment post, and the other of the first and second connector alignment apparatuses including at least one aperture configured to receive the alignment post therein as the removable member is installed on to the frame of the bed to align the first and second electrical connectors before the first and second connectors are mated.

58. The apparatus of claim 57, wherein the frame of the bed includes at least one post extending away from the frame by a distance greater than a height of the second connector alignment apparatus, and the removable member of the bed is formed to include an aperture configured to receive the post on the frame of the bed to provide an initial alignment between the removable member and the frame as the removable member is installed on to the frame.

59. The apparatus of claim 57, wherein one of the first and second connector alignment apparatuses includes first and second spaced apart alignment posts and the other of the first and second connector alignment apparatuses includes

the at least one retention post to permit limited movement of the second connector alignment apparatus relative to the frame of the bed.

66. The apparatus of claim 57, wherein the first electrical connector includes at least one alignment post and the second electrical connector includes an aperture configured to receive the alignment post of the first electrical connector therein to provide further alignment between the first and second electrical connectors.

67. The apparatus of claim 57, wherein the first and second connector alignment apparatuses include keys.

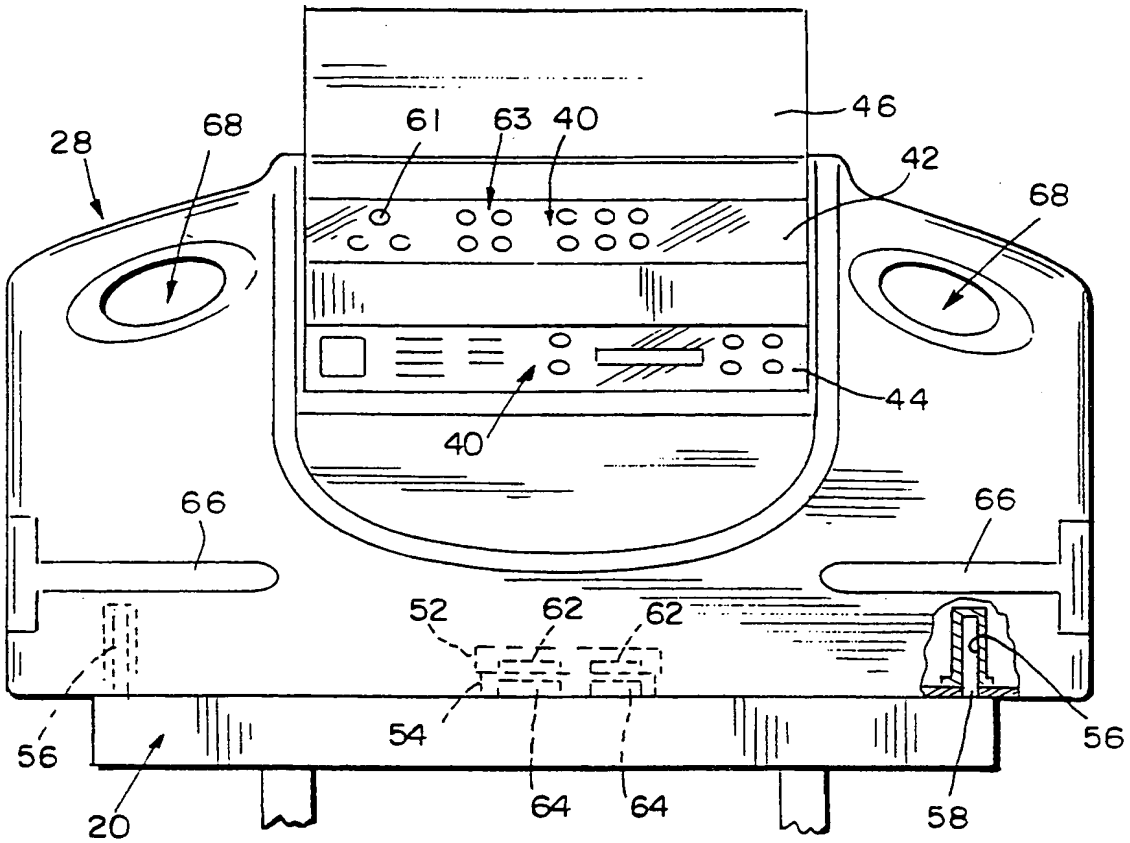
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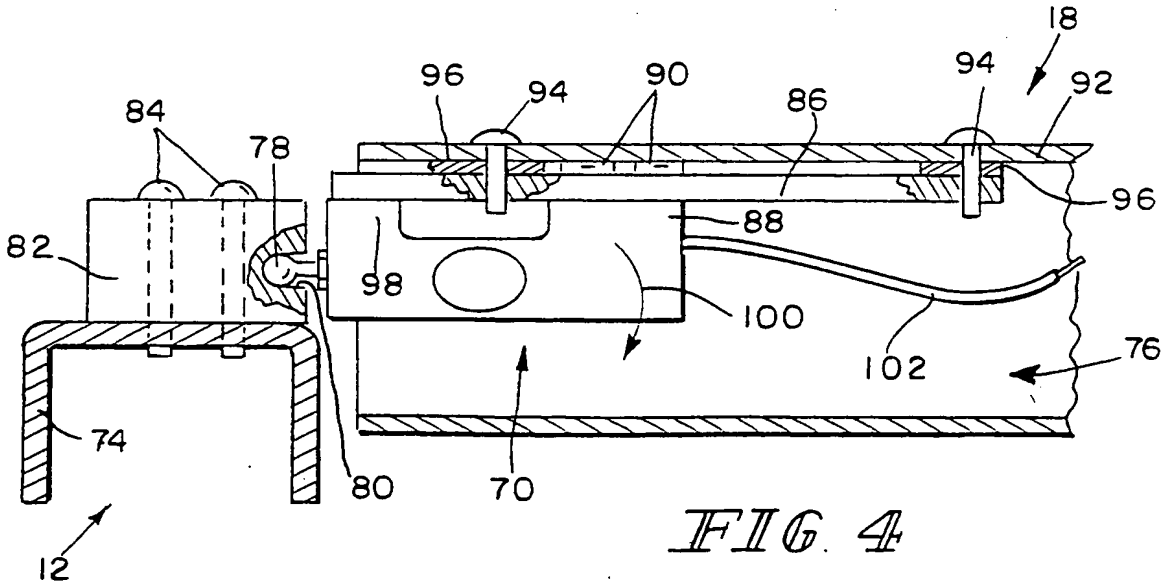
FIG. 2


18
96
94
90
94
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96
82
88
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74
80
70
12

FIG. 4

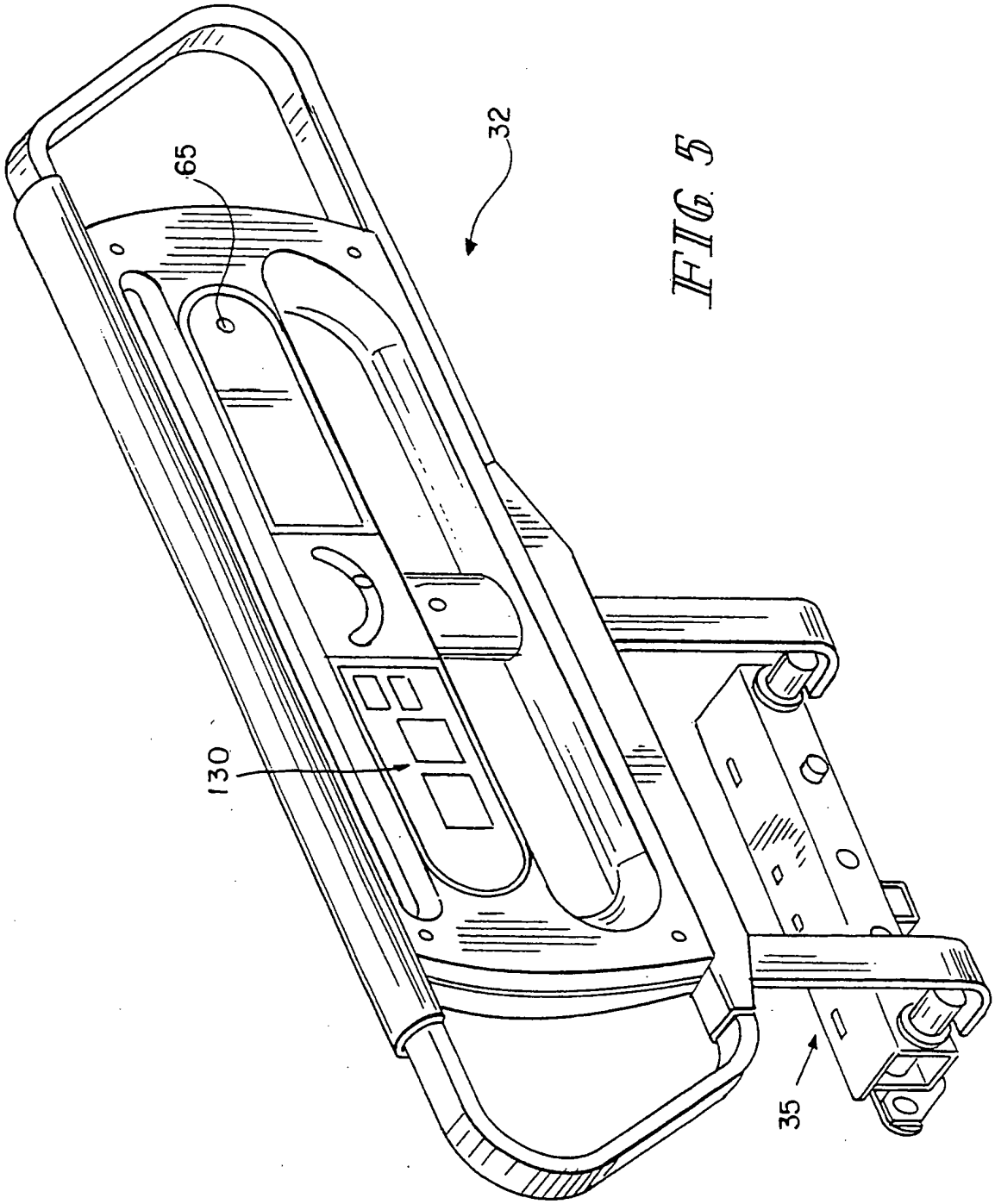


FIG 5

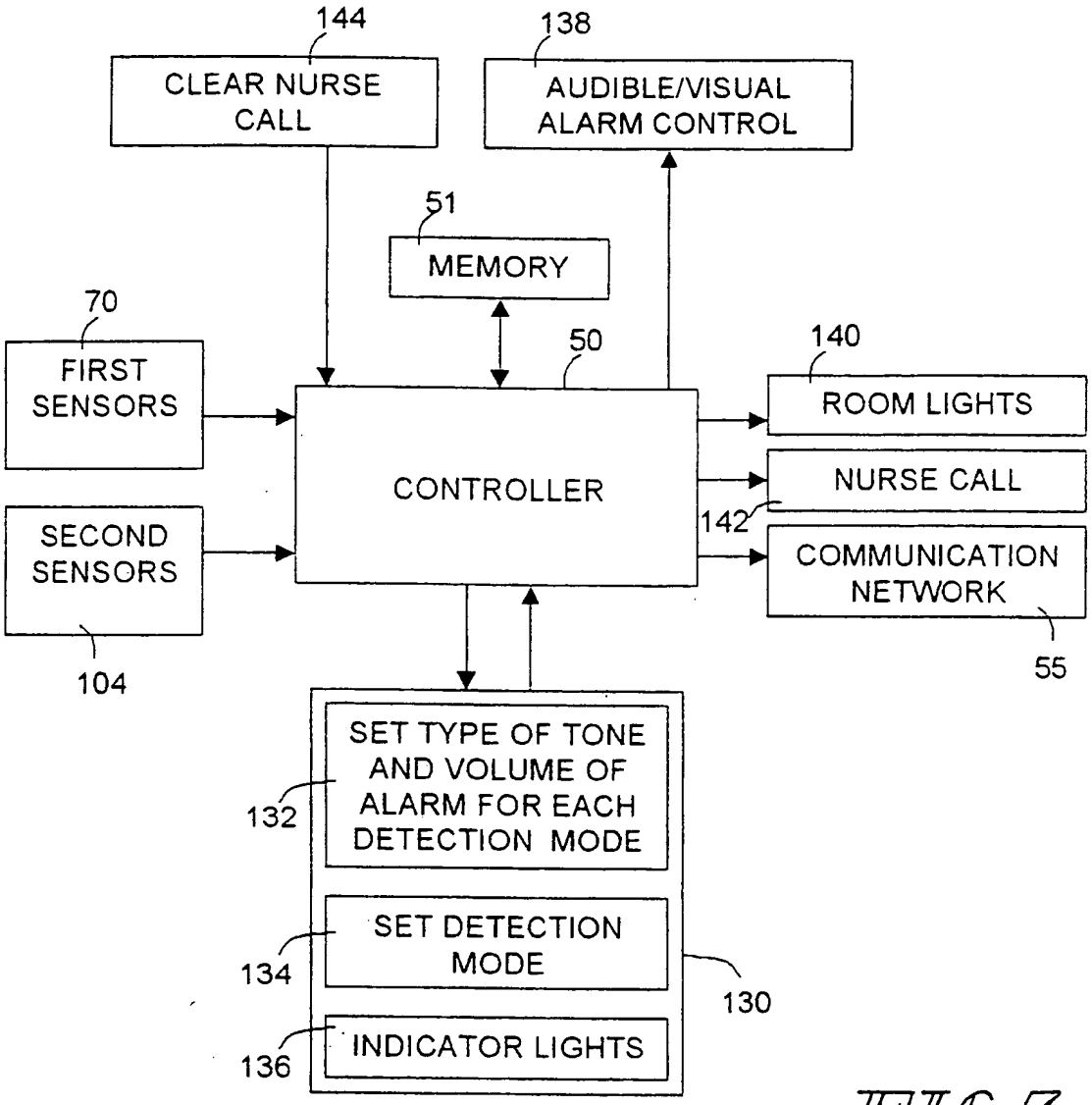
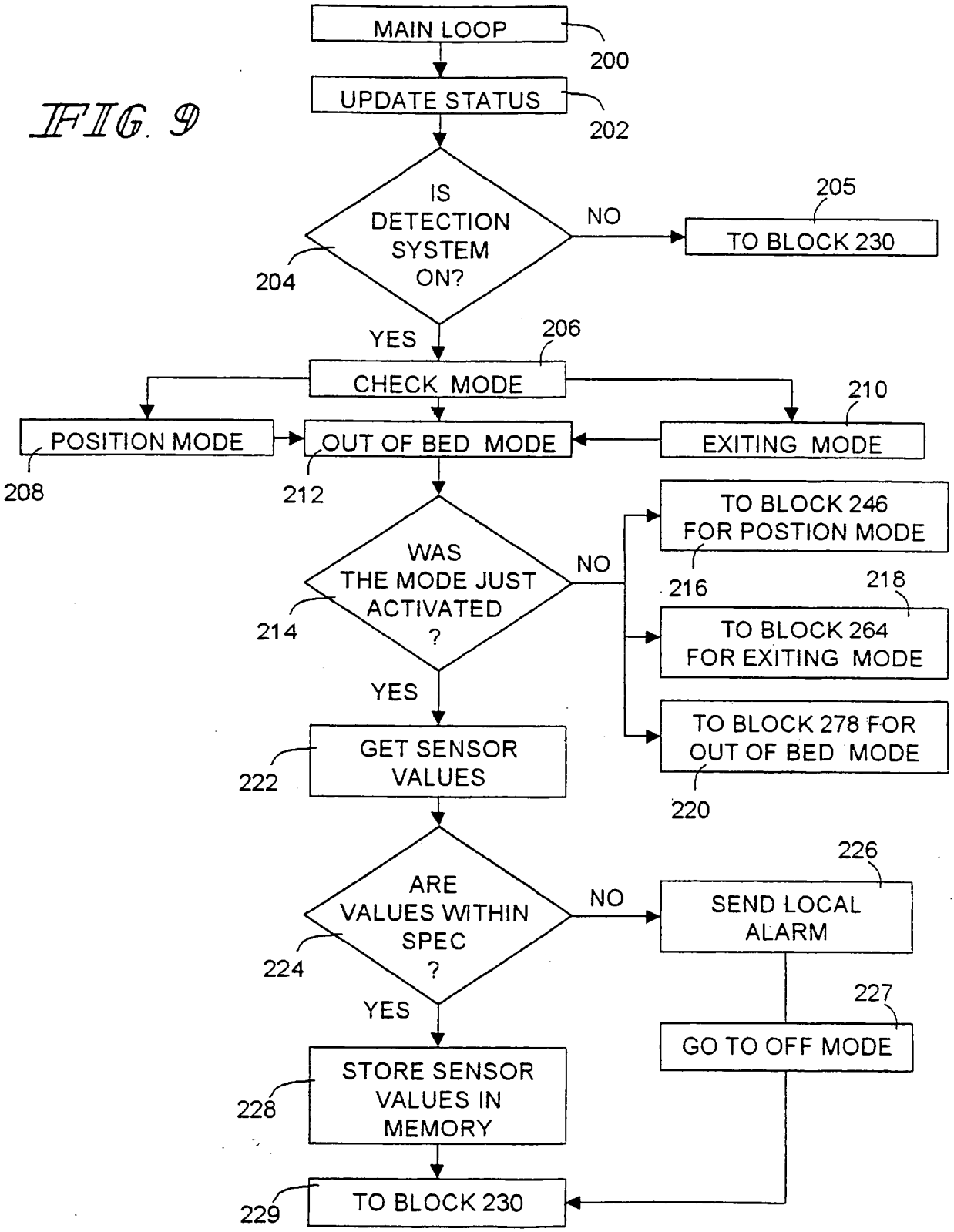

144
CLEAR NURSE CALL
138
AUDIBLE/VISUAL ALARM CONTROL
51
MEMORY
70
FIRST SENSORS
50
140
ROOM LIGHTS
CONTROLLER
NURSE CALL
142
SECOND SENSORS
COMMUNICATION NETWORK
104
55
SET TYPE OF TONE AND VOLUME OF ALARM FOR EACH DETECTION MODE
132
SET DETECTION MODE
134
130
INDICATOR LIGHTS
136

FIG. 1

FIG. 9


MAIN LOOP
200
UPDATE STATUS
202
IS DETECTION SYSTEM ON?
204
NO
205
TO BLOCK 230
YES
206
CHECK MODE
210
POSITION MODE
208
OUT OF BED MODE
212
EXITING MODE
WAS THE MODE JUST ACTIVATED ?
214
NO
TO BLOCK 246 FOR POSTION MODE
216
218
TO BLOCK 264 FOR EXITING MODE
TO BLOCK 278 FOR OUT OF BED MODE
220
YES
GET SENSOR VALUES
222
ARE VALUES WITHIN SPEC ?
224
NO
226
SEND LOCAL ALARM
227
GO TO OFF MODE
YES
STORE SENSOR VALUES IN MEMORY
228
TO BLOCK 230
229

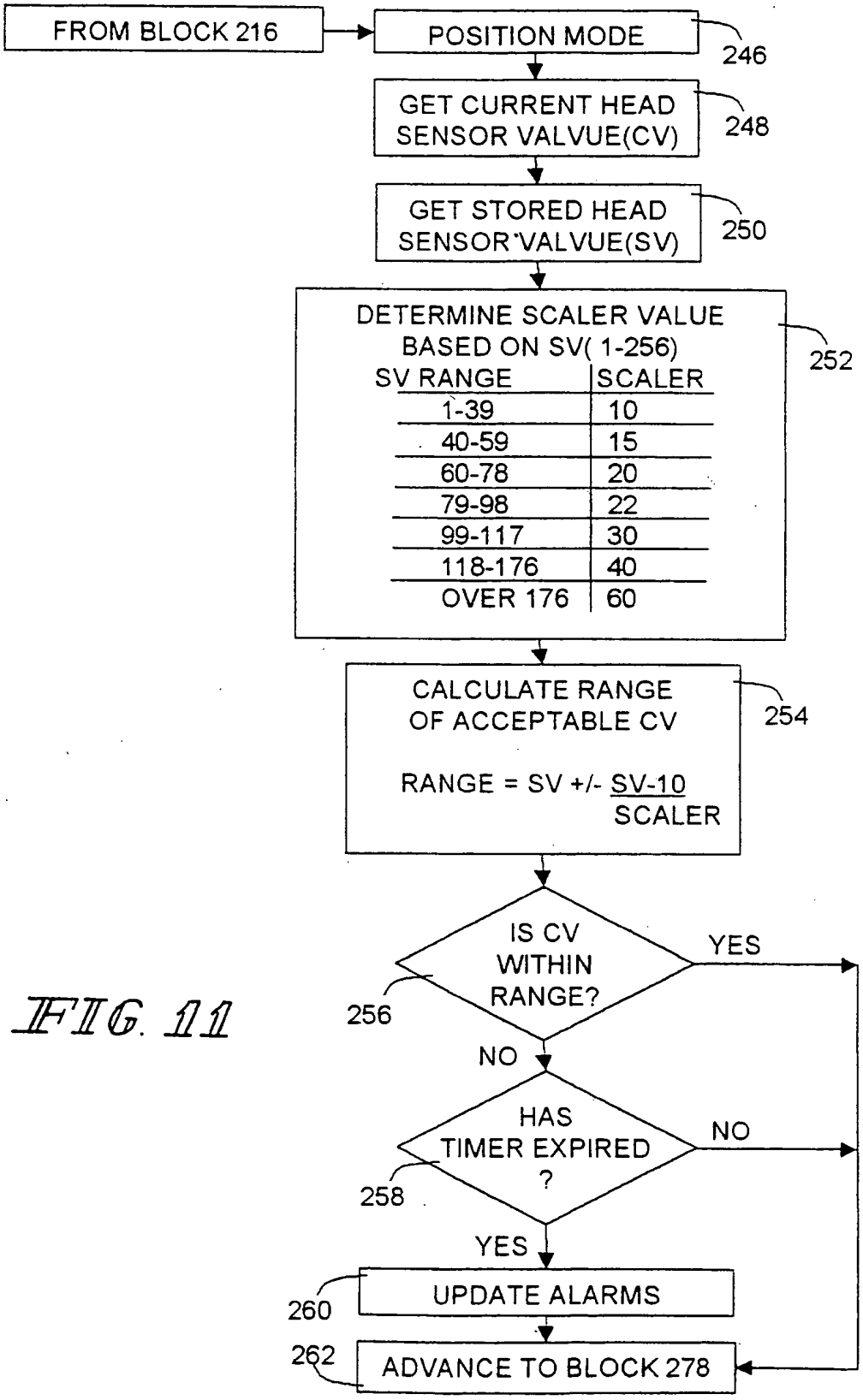

FROM BLOCK 216
POSITION MODE
246
GET CURRENT HEAD SENSOR VALVUE(CV)
248
GET STORED HEAD SENSOR VALVUE(SV)
250
DETERMINE SCALER VALUE BASED ON SV(1-256)
252
SV RANGE | SCALER
1-39 | 10
40-59 | 15
60-78 | 20
79-98 | 22
99-117 | 30
118-176 | 40
OVER 176 | 60
CALCULATE RANGE OF ACCEPTABLE CV
254
RANGE = SV +/- SV-10 / SCALER
IS CV WITHIN RANGE?
256
YES
NO
HAS TIMER EXPIRED ?
258
NO
YES
UPDATE ALARMS
260
ADVANCE TO BLOCK 278
262

FIG. 11

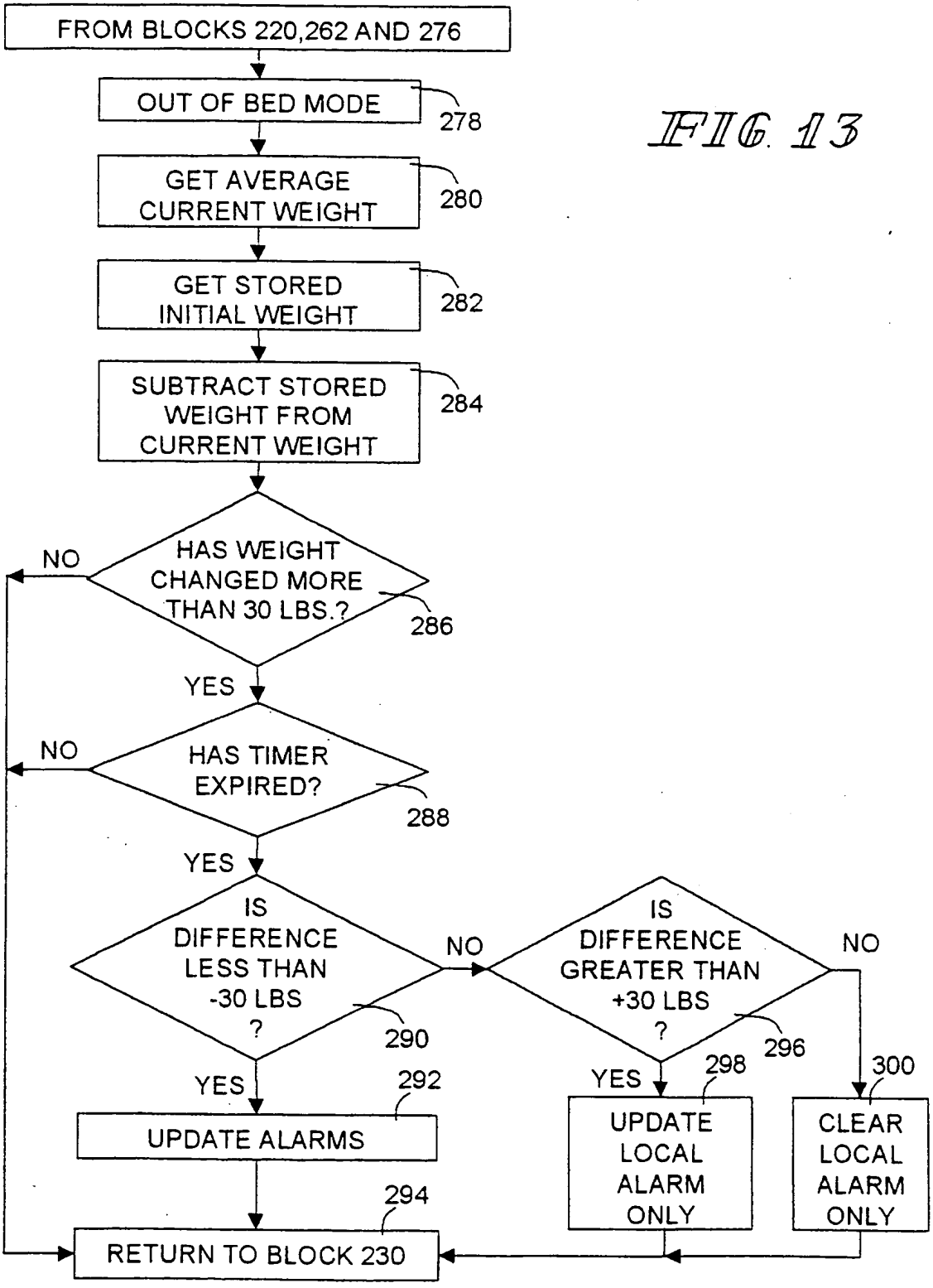

FROM BLOCKS 220,262 AND 276
OUT OF BED MODE
278
GET AVERAGE CURRENT WEIGHT
280
GET STORED INITIAL WEIGHT
282
SUBTRACT STORED WEIGHT FROM CURRENT WEIGHT
284
HAS WEIGHT CHANGED MORE THAN 30 LBS.?
286
NO
YES
HAS TIMER EXPIRED?
288
NO
YES
IS DIFFERENCE LESS THAN -30 LBS ?
290
NO
IS DIFFERENCE GREATER THAN +30 LBS ?
296
NO
YES
298
YES
300
UPDATE ALARMS
292
UPDATE LOCAL ALARM ONLY
CLEAR LOCAL ALARM ONLY
294
RETURN TO BLOCK 230

FIG. 13

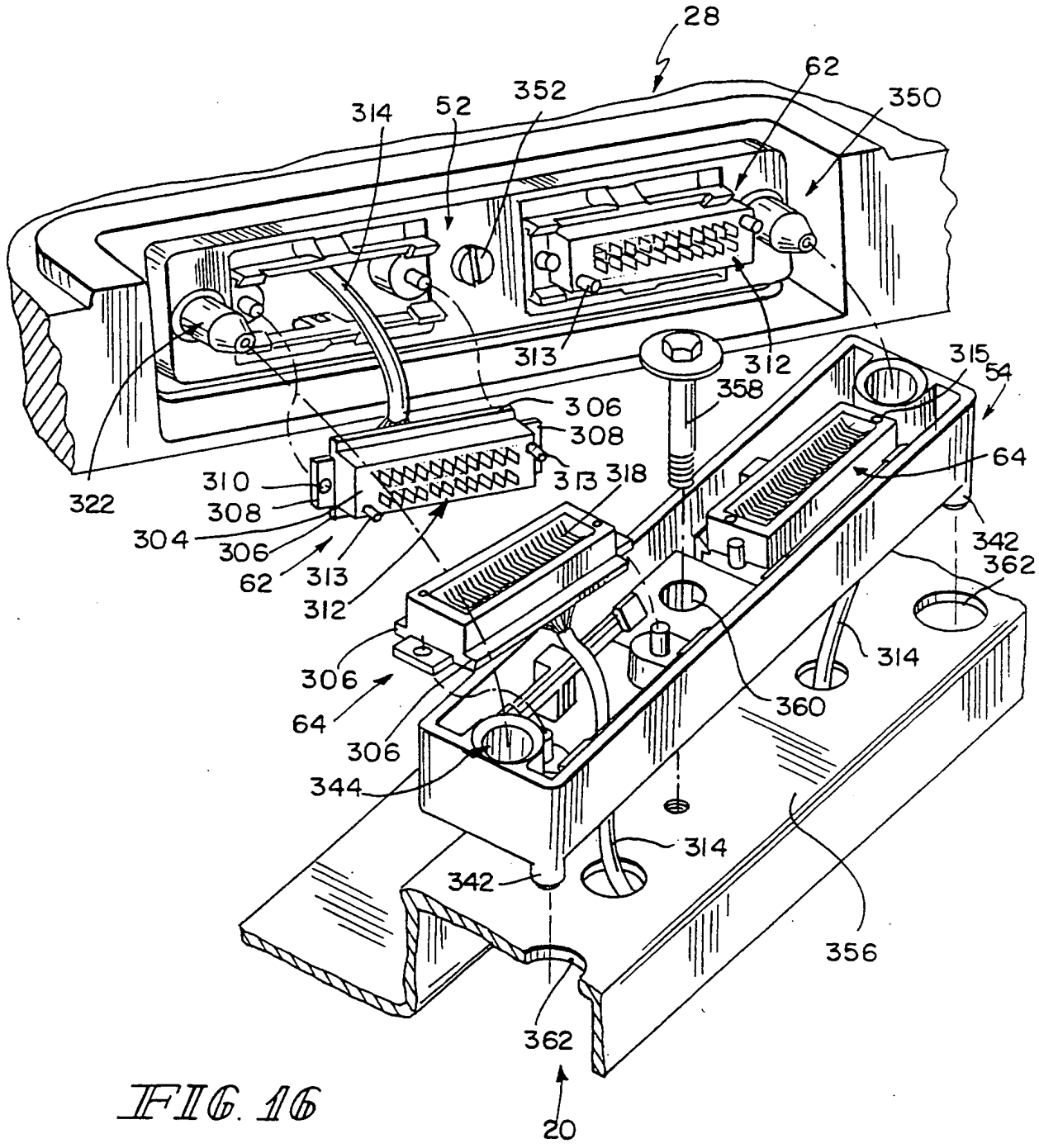

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FIG. 16

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(71) Applicant: **HILL-ROM, INC.** [US/US]; 1069 State Route 46 East, Batesville, IN 47006 (US).

(72) Inventors: **DIXON, Steve, A.**: 9553 Old Woods Drive, Hamilton, OH 45011 (US). **MENKEDICK, Douglas, J.**: 4617 North Dearborn Road, Guilford, IN 47022 (US). **JACQUES, William, L.**: 75 Arlington Drive, Batesville, IN 47006 (US). **JONES, James, W.**: 1155 N.W. 30th Avenue, Gainesville, FL 32609 (US). **FINDLAY, James, F.**: 7497 Timbernline Drive, Fishers, IN 46038 (US). **WILKER, Jack, Jr.**: 1418 Aaron Drive, Shelbyville, IN 46176 (US). **OSBORNE, Eugene, E.**; 2257 Kyle Drive, Hebron, KY 41048 (US).

(74) Agent: **NIEDNAGEL, Timothy, E.**: Bose McKinney & Evans LLP, 2700 First Indiana Plaza, 135 North Pennsylvania Street, Indianapolis, IN 46204 (US).

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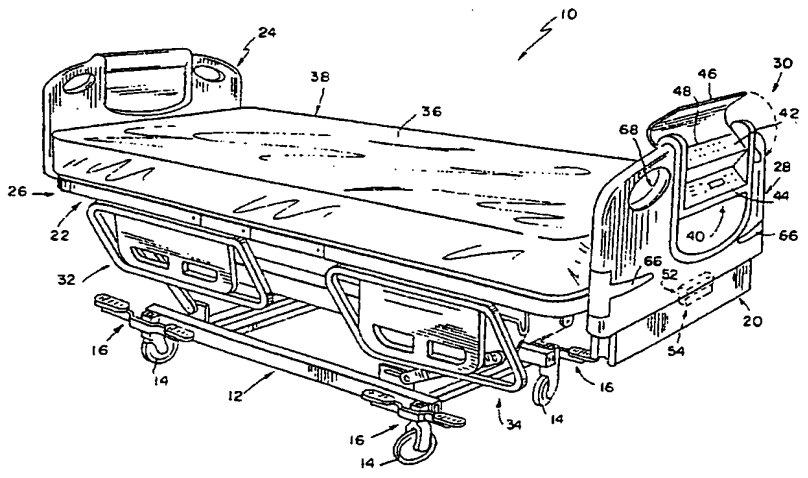
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

[Continued on next page]

(54) Title: PATIENT POSITION DETECTION APPARATUS FOR A BED



(57) Abstract: An apparatus is provided for detecting a position of a body on a support surface (38) of a bed (10). The apparatus includes at least one first sensor (70) coupled to the bed (10) and at least one second sensor (104) located adjacent the support surface (38). The at least one first sensor (70) has an output signal which is variable in response to changes in a weight applied to the support surface (38). The at least one second sensor (104) has an output signal which is variable in response to changes in the position of the body on the support surface (38). The apparatus also includes a controller (50) having inputs configured to receive the output signals from the first and second sensors (70, 104). The controller (50) is configured to monitor the output signals, to provide an indication of changes in the position of the body relative to the support surface (38), and to provide an indication if the body exits the support surface (38).

WO 00/51541 A3

INTERNATIONAL SEARCH REPORT

Internatic Application No
PCT/US 00/05413

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61G12/00 G08B21/00 A61G7/05 H01R13/629

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61G A61B G08B H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 06519 A (HILL ROM CO INC) 20 February 1997 (1997-02-20) page 10, line 16 -page 12, line 22 page 17, line 13 -page 20, line 24 page 24, line 17-25 figures 1,4	1,3, 9-11, 31-44
A		19,21, 23,24, 26,27, 30,45-47

Y	EP 0 844 597 A (HILL ROM CO INC) 27 May 1998 (1998-05-27) column 5, line 54 -column 6, line 25 column 7, line 1 -column 8, line 24 column 11, line 3 - line 29; figures 1,4,8	1-4,6, 8-17, 31-35

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2000	22.08.00

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Rosenblatt, T

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 00/05413

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

1-56

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/05413

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9706519 A	20-02-1997	US 5699038 A	16-12-1997
		AU 6596896 A	05-03-1997
		EP 0880768 A	02-12-1998
		JP 11510286 T	07-09-1999
EP 0844597 A	27-05-1998	US 5808552 A	15-09-1998
		US 6067019 A	23-05-2000
US 5276432 A	04-01-1994	NONE	
US 4539560 A	03-09-1985	CA 1218128 A	17-02-1987
		DE 3344612 A	16-08-1984
		GB 2135089 A,B	22-08-1984
		JP 1710254 C	11-11-1992
		JP 3071131 B	12-11-1991
		JP 59166147 A	19-09-1984
US 5410297 A	25-04-1995	CA 2113124 A	12-07-1994
EP 0860803 A	26-08-1998	GB 2322464 A	26-08-1998
US 5771511 A	30-06-1998	AU 6597096 A	05-03-1997
		EP 0841886 A	20-05-1998
		JP 11510080 T	07-09-1999
		WO 9705844 A	20-02-1997